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*Publication date:*
2013

*Document Version*
Publisher's PDF, also known as Version of record

# High resolution mapping of non-patterned MRAM film stacks

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Center for Individual Nanoparticle Functionality

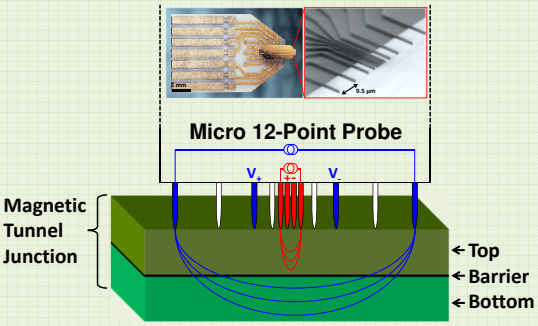
Data Storage Institute
A*STAR

## Production challenge[1-3]

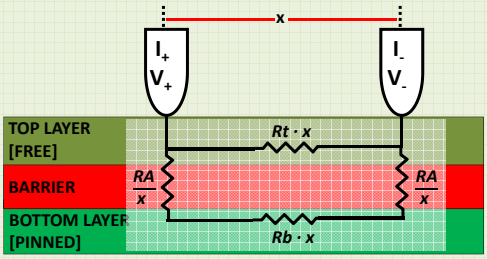
- Unacceptable RA variations across the wafer
- Optimization of production tools requires information of variations

## Standard CIPT measurement routine[4]

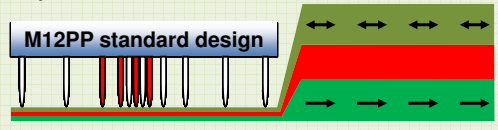
- Switching magnetic field
- Rt, Rb, TMR and RA is measured
- ~94 s / point
- **Measurement time is the limiting factor for high density mapping**

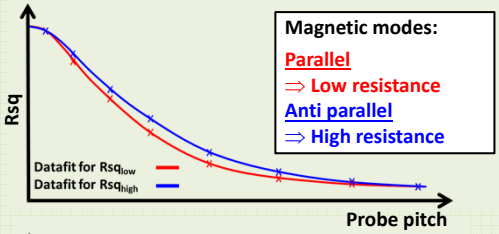


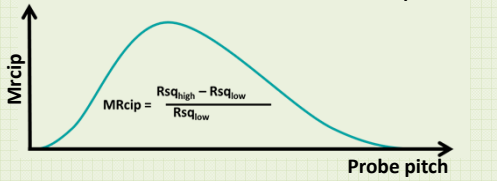

### Two-point measurements on MTJ




### Four-point measurements on MTJ




## RA is the deciding parameter[5-8]

- TMR is maintained at a steady level till close proximity of the egde of the processed area
- Variations in TMR are radially symmetric
- RA starts to decrease significantly at a distance of 50 mm from the wafer center
- Variations in RA are radially assymetric
- **Full wafer map is needed for process optimization**

**Sample:** 200 mm non-patterned MTJ, $Co_{40}Fe_{40}B_{20}$/1 nm MgO/$Co_{40}Fe_{40}B_{20}$

**Figure 1**

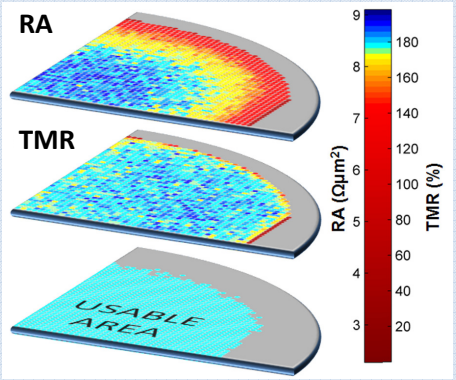



**Fig. 1.** Mapping of RA and TMR with 2 mm step size (1613 points) on a quarter of the sample. Usable wafer area is based on a +/-10 % limit with respect to the mean value at the center of the wafer.

**Figure 2**

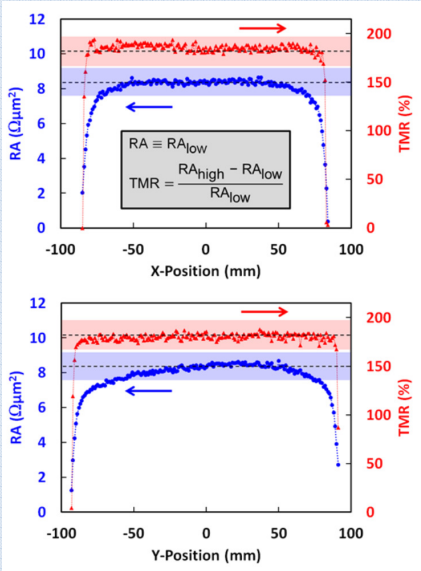



**Fig. 2.** Line scan measurements of RA and TMR with a step size of 1 mm along the X-axis (upper graph) and Y-axis (lower graph) across the sample. The colored areas behind the plots mark a +/-10 % band with respect to the mean values indicated by the dashed lines.

## New static field CIPT measurement routine

- Static magnetic field
- Rt, Rb and RA is measured
- ~13 s / point

**Measurement time is reduced by a factor of 7**

**Figure 3**

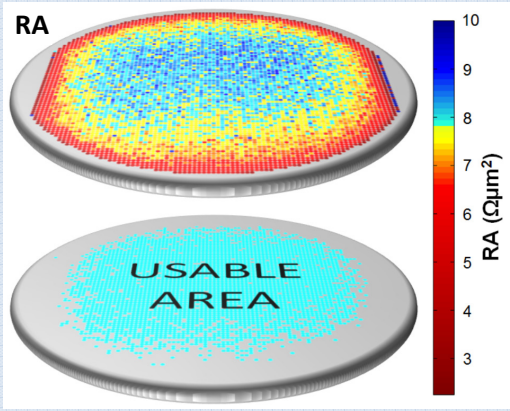



**Fig. 3.** High density map of RA on the full 200 mm wafer obtained with 2 mm step size totaling 6571 measurement points. The usable wafer area vs. edge exclusion zone is based on an acceptance limit of +/-10 % with respect to the mean value at the center of the wafer.

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***Acknowledgements***

The authors are grateful for the financial support of the Danish Ministry of Science, Innovation and Higher Education, the Danish National Research Foundation for funding the Center for Individual Nanoparticle Functionality (DNRF54), the Danish National Advanced Technology Foundation and the Villum Foundation, a non-profit foundation founded by Villum Kann Rasmussen.